

University of Wollongong

Research Online

Faculty of Engineering and Information
Sciences - Papers: Part A

Faculty of Engineering and Information
Sciences

1-1-2014

Applications of controllable smart fluids to mechanical systems

Seung-Bok Choi
Inha University

Norman Wereley
University of Maryland

Weihua Li
University of Wollongong, weihuali@uow.edu.au

Miao Yu
Chongqing University

Jeong-Hoi Koo
Miami University

Follow this and additional works at: <https://ro.uow.edu.au/eispapers>



Part of the [Engineering Commons](#), and the [Science and Technology Studies Commons](#)

Recommended Citation

Choi, Seung-Bok; Wereley, Norman; Li, Weihua; Yu, Miao; and Koo, Jeong-Hoi, "Applications of controllable smart fluids to mechanical systems" (2014). *Faculty of Engineering and Information Sciences - Papers: Part A*. 3313.
<https://ro.uow.edu.au/eispapers/3313>

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library: research-pubs@uow.edu.au

Applications of controllable smart fluids to mechanical systems

Abstract

For this special issue, 20 papers have been received, and three of which have been withdrawn. After strict review processes by the world-wide experts on the smart fluids technology, 10 papers have been accepted and are published here. The published papers cover various application devices and systems, which can be controllable to achieve desired performances by applying the external fields to the smart fluid domains. A brief summary of each application item proposed in the published papers is given as follows.

Keywords

systems, mechanical, fluids, smart, applications, controllable

Disciplines

Engineering | Science and Technology Studies

Publication Details

Choi, S., Wereley, N. M., Li, W., Yu, M. & Koo, J. (2014). Applications of controllable smart fluids to mechanical systems. *Advances in Mechanical Engineering*, 2014 254864-1-254864-2.

Editorial

Applications of Controllable Smart Fluids to Mechanical Systems

Seung-Bok Choi,¹ Norman M. Wereley,² Weihua Li,³ Miao Yu,⁴ and Jeong-Hoi Koo⁵

¹ *Smart Structures and Systems Laboratory, Department of Mechanical Engineering, Inha University, Incheon 402-751, Republic of Korea*

² *Department of Aerospace Engineering, University of Maryland, College Park, MD 20742, USA*

³ *School of Mechanical, Materials and Mechatronic Engineering, University of Wollongong, Wollongong, NSW 2522, Australia*

⁴ *Department of Optoelectronics, Chongqing University, Chongqing 400044, China*

⁵ *Department of Mechanical and Manufacturing University, Miami University, Oxford, OH 45056, USA*

Correspondence should be addressed to Seung-Bok Choi; seungbok@inha.ac.kr

Received 20 August 2014; Accepted 20 August 2014; Published 9 November 2014

Copyright © 2014 Seung-Bok Choi et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Smart fluids have both actuating and sensing capabilities when external input fields such as electric intensity or magnetic intensity are applied. In general, studies have been conducted on smart fluids in several academy societies including chemistry, polymer, physics, and engineering. Recently, four different smart fluids, magnetorheological fluid (MRF) [1], electrorheological fluid (ERF) [2], magnetorheological elastomer (MRE) [3], and electroconjugate liquid [4] are actively being researched in various application fields. Their material characterizations are steadily investigated in terms of controllability of rheological properties such as viscosity and the field-dependent yield stress. However, for last two decades various researches using smart fluids have matured and the development of application technology using these smart fluids has been widely and rapidly undertaken by numerous researchers [5–10]. The inherent controllability of smart fluids has catalyzed broad-based research and development of many different systems including vehicle dampers, vibration control mounts, intelligent hydraulic systems, and smart robots. For the specific application, semiactive shock absorbers, utilizing MRF as the working fluid, have been successfully implemented on several passenger vehicles including Cadillac CTS-V and Ferrari FF. The primary goal of this special issue is to provide timely research in applications, devices, and systems utilizing smart fluids. Especially, this special issue focuses on new design configurations, effective dynamic modeling approaches, improvements in control

efficiency, and ease of implementation along with rigorous simulation and/or experimental methodologies. Therefore, the papers published in this special issue are timely and innovative references for the development of more advanced controllable devices or systems utilizing smart fluids.

For this special issue, 20 papers have been received, and three of which have been withdrawn. After strict review processes by the world-wide experts on the smart fluids technology, 10 papers have been accepted and are published here. The published papers cover various application devices and systems, which can be controllable to achieve desired performances by applying the external fields to the smart fluid domains. A brief summary of each application item proposed in the published papers is given as follows.

B.-K. Song et al. proposed a new type of 4-degree-of-freedom haptic master using MRF which is applicable to a robot-assisted minimally invasive surgery system and experimentally investigated a repulsive torque tracking controllability. Y.-T. Choi et al. analyzed flow mode MRF dampers with an eccentric annular gap using a rectangular duct with a variable gap as well as Bingham-plastic constitutive model of the MRF and compared damper characteristics with the conventional MRF damper which has a concentric gap. Y.-J. Shin et al. applied MRF lateral damper to the secondary suspension of the railway vehicles in order improve ride quality by activation of sky-hook controller and verified its effectiveness by undertaking experimental test of a 1/5 scale

model on the roller rig. Y. Sakurai et al. proposed a new cooling system using an electroconjugate fluid (ECF), which can be applied to CPU cooling in a personal computer, and experimentally investigated its cooling performance by implementing an ECF-pump that generates a strong jet flow between electrodes. J. Fu et al. proposed a hybrid isolator by using MRE elastomer and piezoelectric stack actuators in order to achieve better vibration suppression and experimentally demonstrated its effectiveness by presenting vibration control levels in frequency domain. X. Gong et al. proposed MRF damper operated under squeeze mode in which the direction of the damper is parallel to the direction of the external magnetic field and experimentally investigated the field-dependent damping force by changing the magnitudes and frequencies of excitation signals. G. Hu et al. proposed a double coil MRF valve with an outer annular resistance gap and optimized the magnetic field distribution and magnetic intensity of the flow path using a finite element method to achieve maximum pressure drop with a low input field. P. W. Nugroho et al. proposed an adaptive neurofuzzy hybrid controller for a semiactive suspension with MRF damper and performed computer simulations to demonstrate control performances in terms of displacement and acceleration of the sprung mass and tire deflection. F. Guo et al. proposed a new viscoelastic parameter model of MRE based on an Abel dashpot and experimentally tested the material properties in dynamic conditions in order to validate the effectiveness of the proposed parametric constitutive model by adopting five groups of MRE samples, which consist of silicone rubber with different volume fractions. J. Zheng et al. proposed a novel MRF damper with a multistage piston and independent input current in order to reduce energy consumption as well as to achieve high damping performance at high velocity condition and undertook computer simulation to demonstrate the effectiveness of the proposed damper mechanism by considering the temperature at the piston.

Acknowledgments

We very much appreciate all the authors' excellent contributions to this special issue and the reviewers' efforts to rigorously examine the submitted papers.

Seung-Bok Choi
Norman M. Wereley
Weihua Li
Miao Yu
Jeong-Hoi Koo

References

- [1] J. de Vicente, D. J. Klingenberg, and R. Hidalgo-Alvarez, "Magnetorheological fluids: a review," *Soft Matter*, vol. 7, no. 8, pp. 3701–3710, 2011.
- [2] H. G. Lee, S. B. Choi, S. S. Han, J. H. Kim, and M. S. Suh, "Bingham and response characteristics of ER fluids in shear and flow modes," *International Journal of Modern Physics B*, vol. 15, no. 6-7, pp. 1017–1024, 2001.
- [3] B. X. Ju, M. Yu, J. Fu, Q. Yang, X. Q. Liu, and X. Zheng, "A novel porous magnetorheological elastomer: preparation and evaluation," *Smart Materials and Structures*, vol. 21, no. 3, Article ID 035001, 2012.
- [4] W.-S. Seo, K. Yoshida, S. Yokota, and K. Edamura, "A high performance planar pump using electro-conjugate fluid with improved electrode patterns," *Sensors and Actuators A: Physical*, vol. 134, no. 2, pp. 606–614, 2007.
- [5] S. B. Choi and Y. M. Han, *Magnetorheological Fluid Technology: Applications in Vehicle Systems*, Taylor Francis, CRC Press, Boca Raton, Fla, USA, 2012.
- [6] N. M. Wereley, J. U. Cho, Y. T. Choi, and S. B. Choi, "Magnetorheological dampers in shear mode," *Smart Materials and Structures*, vol. 17, no. 1, Article ID 015022, 2008.
- [7] W. H. Li, H. Du, and N. Q. Guo, "Finite element analysis and simulation evaluation of a magnetorheological valve," *International Journal of Advanced Manufacturing Technology*, vol. 21, no. 6, pp. 438–445, 2003.
- [8] S.-B. Choi and Y.-M. Han, "Vibration control of electrorheological seat suspension with human-body model using sliding mode control," *Journal of Sound and Vibration*, vol. 303, no. 1-2, pp. 391–404, 2007.
- [9] K.-G. Sung, M.-S. Seong, and S.-B. Choi, "Performance evaluation of electronic control suspension featuring vehicle ER dampers," *Meccanica*, vol. 48, no. 1, pp. 121–134, 2013.
- [10] J. D. Carlson and M. R. Jolly, "MR fluid, foam and elastomer devices," *Mechatronics*, vol. 10, no. 4, pp. 555–569, 2000.

